HEXAHEDRAL ADAPTIVE MESH GENERATION USING FUZZY LOGIC AND LOCAL REFINEMENT

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3-D finite element method (FEM) is widely used as an effective numerical simulation technique. In the simulation technique, accuracy is one of the most significant issues. In case of FEM, the accuracy is affected by number of freedom and shape of each element. Generally, a fine mesh can provide more accurate result than a coarse one, and needs more time of calculation and more computer resources (memory, CPU speed and disk space). Recently tetrahedral automatic mesh generation and adaptive mesh generation become advanced and practical. Hexahedral mesh generation and its adaptation are not enough to use for practical applications, because its mesh generation is very difficult and still labor intensive work by hand. In recent years local mesh refinement for a tetrahedral element is widely used in order to avoid failure of mesh regeneration and to be easily applied any tetrahedral meshes.

We utilized following three techniques in order to obtain well controlled and adaptive hexahedral meshes.

- Error Estimation[1]
- Determination of elements to be refined using Fuzzy logic
- Adaptive mesh generation using local mesh refinement[2,3]

Zienkiewicz and Zhu error estimator[1] is utilized, because the test cases are linear stress analysis. Of course we should choose an appropriate error estimator according to a kind of analysis. One of the most important purposes is satisfaction of user's request. The request contains several conditions which are user's preference, type of analysis, memory size, CPU frequency, memory band width and etc. Expert engineers can create optimized mesh for their application and computer environment in consideration of such conditions. Fuzzy logic control is found to be very suitable for representation of knowledge and experience. In proposed system fuzzy logic determines elements to be refined by min-max method. Local mesh refinement requires an initial hexahedral mesh, but it can be refined without any failures. Indeed many distorted elements are generated, but such elements are not located in the area of stress concentration. The effect of such distorted elements is evaluated in regard to error norm. In this study we present a method to generate an appropriate mesh for user's demand from an existing hexahedral mesh using error estimation, fuzzy control and hexahedral local refinement.

References

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